

## American Maglev Technology



Technology/Propulsion: Maglev

Max Speed: 120-150 mph

Passengers: 93 seated per car, 200 per pair

With a strong focus on sustainability, AMT's transit technology is based on optimized magnetic levitation and linear induction propulsion that is entirely electric and non-polluting. This technology can operate in Colorado's terrain, because it is designed to traverse steep grades of up to 10%. Daily passenger demands can be accommodated with vehicles that will comfortably carry approximately 200 passengers as well as their luggage and recreational equipment, while offering an excellent level of service with wireless internet and restroom facilities. Traveling by AMT technology will reduce trip times between DIA and Vail; the trains are designed to operate faster than a car in free-flow conditions. The technology can operate atop a grade-separated, dedicated guideway within the I-70 corridor -- no additional rights-of-way are needed. The technology is fully automated and requires little maintenance, therefore featuring very low capital and operating costs that can be recovered by reasonable transit fares and revenues. AMT technology is fully compliant with the US FTA Automated Peoplemover Code and all applicable regional standards. Since its inception in 1994, AMT has invested millions of dollars in research and development of its advanced zero-emitting, next-generation transportation technology, which has attracted world-class strategic partners and significant corporate investment. In April 2010, AMT signed a 10-year exclusive partnership with Grupo ACS for joint development of transportation projects worldwide. In August 2012, the team contracted with Lockheed-Martin to add tremendous manufacturing and technical expertise to the team.

## FlightRail



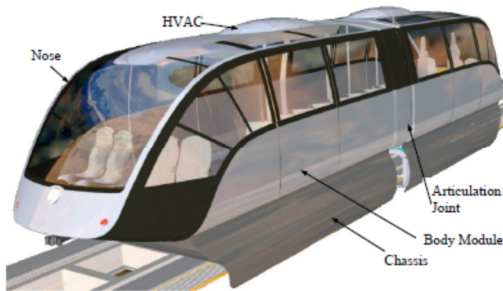
Technology/Propulsion: Pneumatic compression w/ Magnetic Traction

Max Speed: 140 mph

Passengers: 80 seated per car

The VECTORR™ is a high-speed, light weight atmospheric transportation system that uses vacuum/air pressure to move passenger modules along an elevated guideway. Stationary power systems create vacuum/pressure inside a continuous pneumatic tube located centrally below rails within a truss assembly. As these power systems pull the air from the tube, they create a vacuum in front of a free piston that is rail-guided inside the power tube. The free piston is magnetically coupled to the passenger modules above. Additionally, air enters the tube behind the free piston to create a differential pressure. The magnetic coupling allows the interior of the power tube to be a closed system to maintain the desired pressure differential in the tube. The transportation unit operates above the power tube on a pair of parallel, steel rails which receive, support, and guides the wheels of the truck assemblies. The passenger modules feature independent wheels angled at 45° that are locked onto the rails. This wheel configuration allows the system to operate in severe weather conditions. Since traction conditions are not required, the guideway can be lubricated for reduction of friction and noise abatement. Flight Rail Corp. currently has a 1/6<sup>th</sup> scale pilot model operating on an outdoor test guideway. The guideway is 1,500 feet long and incorporates 2%, 6%, and 10% grades. The pilot model operates at speeds up to 25 m.p.h. which equates to a scale speed of 150 m.p.h. Preparations are being made to extend the guideway an additional 700 feet to include a 180° curve with a 48 foot radius. This equates to a full size train operating on a 288 foot radius or 20° curve (at restricted speeds). The foregoing characteristics fit well with the requirements of the I-70 Corridor. The power tube and supporting structure are very adaptable to enabling ice and snow removal and also serve as a power distribution platform related to power requirements between power stations.

## General Atomics



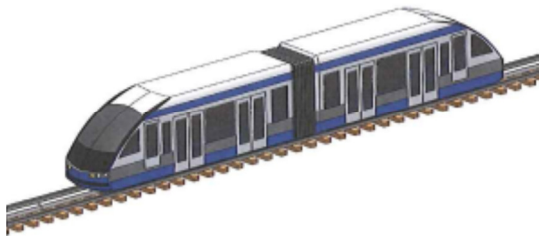
Technology/Propulsion: High-Speed Maglev

Max Speed: 150 – 300 mph

Passengers: 40 seated per car (one joint) or  
100 seated per car (two articulation joints)

More than 30 firms and financial institutions, in close concert with the Federal Transit Administration (FTA), have collaboratively developed the technology proposed for installation along the I-70 mountain corridor. The Colorado MAGLEV Group is prepared to commence immediately to finance, design, build, operate, maintain and own or lease an advanced guideway transportation system that serves the needs of corridor communities. Research that shaped this technology started in 1990 and more than \$40 million from, private, federal, and state sources have been spent during its development. General Atomics believes it to be the most advanced, American-designed MAGLEV technology currently available for transporting freight and passengers. The \$14 million test track constructed at the General Atomics campus in La Jolla, California, has demonstrated that the following performance characteristics would serve the unique service demands of the I-70 corridor: (1) no right-of-way purchases would be required as the technology can be placed entirely within the existing I-70 envelope, (2) the system can be deployed on an elevated structure supported by 30 to 60 foot columns holding 80 to 100 foot double track guideway platforms (22 ft. in width) that can be produced locally and placed with light cranes deployed from completed sections, (3) the capital costs of the guideway are only a third those of light rail or rubber tire alternatives, (4) operating and maintenance costs are estimated to be one-fourth those of rail systems, (5) environmental impacts (esp., noise and emissions) are minimal as the MAGLEV technology is friction free and relies on a linear synchronous motor for propulsion which is embedded in the guideway, (6) the system should operate reliably (99+%) in all but the most extreme weather conditions and command grades of as much as 15% without a degradation in speed or performance, (7) the esthetics of columns and structures supporting the vehicles, including stations, can conform with community preferences, (8) speeds of 150 mph on the I-70 corridor are possible with headways of as little as 20 seconds, (9) 100-passenger cars in four car trains would be standard, and (10) it has been demonstrated that this technology can carry standard truck containers using the existing guideway configuration.

## Magnemotion



Technology/Propulsion: Maglev

Max Speed: 100 mph

Passengers: 36 seated (small vehicle) or  
80 seated (larger vehicle)

The MagneMotion Maglev System “**M3**” is designed as the “green” alternative to all conventional guided transportation systems. Efficient Linear Synchronous Motor (LSM) propulsion and control enables small, closely spaced, light weight vehicles to meet passenger capacities of 12,000 people per hour per direction at an estimated cost of \$30M per km of dual guideway (after land acquisition and station costs). Operational costs are reduced with automated controls, reduced power requirements, and regenerative braking. Trip times are reduced with higher accelerations and greater vehicle density. **M3** development has been funded as part of a cooperative agreement between MagneMotion and the Federal Transit Administration. There are two operating test systems, one indoors at MagneMotion, and a second outdoor demonstration system at Old Dominion University in Norfolk Virginia. These systems have met their design goals and as of October 31, 2012, have logged a combined total of more than 6,850 km, 1,084 hours and 145,500 start and stop cycles.

## MegaRail



Technology/Propulsion: Electric Wheelway

Max Speed: 85-120 mph

Passengers: 8 seated per vehicle, usually 4 vehicles/train = 32 seated per train (with luggage in each vehicle)

High-speed **MegaWay** systems provide electrified, all-elevated, maintenance-free stainless steel **SuperWays**<sup>™</sup> and a family of electrically powered, rubber-tire vehicles that operate in a similar manner to that of road vehicles on standard freeways. It is a multi-purpose system capable of transporting passengers, people in their own, standard cars, and both light and heavy cargo intermixed on the same **SuperWay**. It offers a high-speed, low-cost, electrically powered, low air pollution, *all-weather* alternative to cars and trucks on roads with traffic capacity equivalent to that of a six-lane freeway. Passengers ride seated in comfortable cabins or in their own standard cars. Light and heavy cargo is carried in enclosed, weatherproof containers fully compatible with standard flatbed and box trucks. Factory-built **SuperWays** include enclosed wheelways that contain traction surfaces, wheels, power pickups, power and steering rails, position references, digital communication links and failure-tolerant guideway control systems. The unique wheelways protect all functional items from weather. Full operation is possible in all-weather conditions including 150-mph winds. The 600-vdc power used by vehicles is generated by small, natural gas powered generators on **SuperWay** support columns. Welded, stainless steel gas supply lines are supported below the **SuperWay**. Standard grid power lines or substations are not required.

## Owen Transit Group



Technology/Propulsion: Monorail

Max Speed: 150-220 mph

Passengers: 48 seated per vehicle

OTG offers both high-capacity transit and high speed rail systems, using individual passenger vehicles running quietly in two directions on opposite sides of a single elevated concrete monorail beam, high above the snows and traffic. The systems require no changes to existing roadways, and use tilting cabin design for operating within the curving I-70 corridor. They have very high horsepower variable-frequency drive (VFD) electric motors for ascending mountain grades while using multiple brake systems for descending mountain grades, returning power to the electrical grid. Rails are steel, heated to remove ice and snow. Construction costs per mile are low, as are the operating costs for the automated systems, allowing them to be self-sustaining with competitive fares. Although they have not yet been built as systems, the technology is proven because it uses proven, in-service, off-the-shelf components.

### PPRTC



Technology/Propulsion: Electric Guideway

Max Speed: 120-150 mph

Passengers: 4 seated per vehicle

The PPRTC template for urban efficiency starts with a Personal Rapid Transit (PRT) system, or pod-cars on a fixed guideway that deliver 1 to 4 passengers at-a-time or freight container(s). The vehicles use an air lifting mechanism integrated with magnetic induction propulsion. The cushion of air generated underneath the pod-car takes the place of maintenance-intensive wheels effectively eliminating friction; sequential application of electromagnets between the guideway and vehicle accelerate, brake and stop the vehicle. The elevated guideway, which preserves grade level spaces, also serves as the conduit of system power and telecommunications. Housing the power and fiber-optic communications components inside the PRT's carbon-fiber pylons and guideway makes them impervious to extreme weather. The generation of system power occurs onsite at each PRT station using Hydrogen Fuel Cells (HFCs) initially fed by natural gas, eventually migrating to a diversity of renewable sources of hydrogen. With a Microgrid Power Management (MPM) scheme, realtime data and keen predictive formulae are used to control generation with surgical precision. HFC generation and MPM together make it possible to achieve a zero carbon footprint while having zero impact on the grid. PRT, whether at high or low speed, as a trip experience is "rapid" due to never waiting for transit per schedule and never stopping en route, that is, point-to-point and on-demand. These two features, intrinsic to the PRT model, plus the fact that it is a driverless medium (50-75% of the cost of transit), make it significantly more efficient than conventional modes saving time, energy and money for the operator and the rider.

### SkyTran



Technology/Propulsion: Suspended Maglev

Max Speed: 100 mph

Passengers: 2 per vehicle

SkyTran is an Automated Transit Network (ATN) technology that provides on-demand, point-to-point, non-stop service. These characteristics boost ridership by providing a level of performance, convenience and comfort that meets or exceeds an automobile ride. SkyTran uses a fleet of two-passenger automated electric vehicles (AEV) that travel on a network of slim, elevated guideways. The AEV uses a breakthrough maglev-linear motor powertrain that delivers high-speeds (100 mph), high reliability (no wheels to fail) and a comfortable ride (seats wider than a first-class airline seat). SkyTran technology is designed for building scalable networks. This capability is ideal for the AGS as SkyTran can provide direct feeder service to mountain communities by making a no-transfer connection to the main I-70 alignment. SkyTran's vision is to deliver the ultimate customer experience: a one seat ride from Denver International Airport to the ski resort of your choice.



### SwiftTram



Technology/Propulsion: Suspended Monorail

Max Speed: 100 mph

Passengers: 8 (small) or 32 (big) seated

Swift Tram is in business to manufacture a new rapid transit system based on the century-old concept of the hanging train. Swift Tram is a people-mover and freight-mover that's electrically powered and elevated. It's a fully automated fixed guideway transportation system featuring coaches in two sizes suspended from the guideway by a hinge. Drive bogies traveling inside the guideway at speeds that can exceed 100 miles per hour provide 'swarm computing' intelligence, system diagnostics, and routine system maintenance. System operation is designed to be available on both a scheduled and an on-demand 24/7 basis. Swift Tram is a Boulder Colorado-based startup in design and engineering stage, currently applying for patents on 12 technology elements of the system. Swift Tram is proactively addressing the issues of grid power outage and emergency & ADA passenger evacuation. This right-sized, light-footprint system is considerably less expensive to install than light rail, and is considerably less expensive to operate than BRT. The company is creating the safest, cleanest, most cost-effective, and most energy efficient rapid transit system in the world.

### Talgo



Technology/Propulsion: Electric / Dual-Mode

Max Speed: 186 mph

Passengers: 21-36 seated per car,  
300 per 10-car consist

Talgo offers a unique combination of innovation and proven technology that assures a high degree of satisfaction among all concerned, passengers, owners and operators. Furthermore, the equipment Talgo proposes will be fully compliant with US DOT, Federal Railroad Administration regulations and fully compatible with the US railway network, eliminating regulatory uncertainty while providing unexcelled flexibility for years to come. Talgo's "independent wheels" and "natural tilting" system reduce wheel wear and permit faster speeds within the I-70 right-of-way than will be possible with conventional railroad equipment, yet the technology used to produce this result has proven itself over nearly three decades' of continuous service. Propulsion energy is expected come from the commercial electric grid and be applied to the rail using frame hung traction motors and conventional adhesion. (Talgo is not proposing a cog railway). Consistent with other technologies, an additional tunnel bore will be needed at or near the E-J Memorial Tunnel. In addition, judicious use of deviations from the I-70 alignment will reduce trip time. The optimal quantity and length of these deviations, based on balancing initial cost and the trip-time benefit of that cost, can be determined when (and only when) the cost of each has been estimated and the value of time saved is established. Talgo has experience in performing cost-benefit analyses of train performance with computer simulation software to identify the most critical sections that should be adapted to reduce the journey time to the CDOT's goals. Regenerative braking will be used to minimize the net power requirement, likely producing the most energy efficient form of transportation that will be offered.

## Transrapid



Technology/Propulsion: High-speed Maglev

Max Speed: 250-330 mph

Passengers: 80-100 seated

Transrapid is quiet, comfortable, fast, safe, clean, and reliable: one of the most modern high-speed Transportation Systems in the world. Developed over the last 30 years in Germany, the Transrapid high-speed Maglev system consists of the electromagnetic levitation, the guidance and the propulsion system. Support magnets lift the vehicle up from the guideway, while guidance magnets located on both sides of the vehicle keep the vehicle lateral to the track. The synchronous long-stator motor acts as both, the drive and the braking system. The drive, consisting of stator packs with a three-phase traveling field coil is built into the guideway rather than into the vehicle. Here electricity produces an electromagnetic travelling field which either pulls the train forward or slows it gently down. The train speed is continuously variable and controlled via the frequency of the alternating current. Since the electromagnetic traveling field determines the direction of movement, it is impossible for two vehicles to move towards each other. Derailments are not possible since the vehicles wrap around the guideway. Transrapid today is well-proven, and in day-in-day-out revenue operation in Shanghai China. Since the Pudong International Airport Connector went into operation in 2004 it has travelled more than 6.5 million miles and 32 plus million people have taken the 19 mile ride between the Airport and Shanghai, operating seven days per week at a punctuality of 99.9 %. It is further developed today with emphasis on system capital cost reduction and even lower electric energy consumption per seat and mile traveled. Transrapid is capable of overcoming the stringent grade differentials, is able to maneuver the tight curves in the I-70 corridor ROW and can meet the challenges of the Colorado weather. Transrapid is proven and ready to be deployed. Safety certifications have been granted in Germany and in China. In a 'Memorandum of Understanding' the German Government and the FRA have addressed a cooperation to jointly develop the 'Rules of particular Applicability' in order to arrive at the safety certification for a U.S. Transrapid Maglev System. It is the intent of Transrapid to engage in a 'Technology Transfer' with qualified American companies to manufacture the system components in the U.S. rather than to import. This approach could foster the formation of a U.S. high-speed passenger transportation industry, started and based in Colorado.